

27. Some Observations on the Structure and Life-History of the Common Nematode of the Dogfish (*Scyllium canicula*). By J. H. LLOYD, M.Sc., F.Z.S., Assistant Lecturer and Demonstrator in Zoology at University College, Cardiff.

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(Text-figures 1-3.)

Introduction.

In the following pages an account is given of the parasitic Nematode, *Proleptus scillicola*, together with some observations on its life-history. The work was carried out, partly in the Zoological Department of the University of Birmingham and partly at the Marine Biological Laboratory at Plymouth, towards the end of 1914 and the beginning of 1915, but until now I have been unable to write up my results for publication, owing to my absence on military service.

I should like here to express my gratitude to Professor F. W. Gamble for his kindly criticism and advice during the course of this work. My thanks are also due to the Board of Studies in Zoology of the University of London for the use of their table at Plymouth, and to the Royal Society for providing a grant which enabled me to procure the necessary material.

A description has been thought desirable because, although the worm is exceedingly common, no complete account of its anatomy exists, and its life-history has never been worked out.

Proleptus scillicola occurs in the alimentary canal of *Scyllium canicula* from the mouth to the pyloric constriction. It has also been reported from *S. catulus* (5), *S. stellare* (1), *Raia clavata* (1), and *Raia circularis* (1). I have only had the opportunity of examining one *Scyllium catulus*, and this specimen was absolutely free from infection.

Other species of the same genus under a different generic name have been reported and briefly described as follows:—*Spiropterina inflata* (8) Linstow, attached to the wall of the stomach of *Scyllium immoratum*; *Spiropterina africana* (6) Linstow, from stomach of *Anguilla* sp. (?); *Spiropterina elegans* (12) Örley, from the stomach of *Hexacanthus griseus*; *Spiropterina dactnodes* (4) Creplin, from the œsophagus of *Raia clavata* and the stomach of *Squalus mustelus*.

The worms are white in colour, and occur either free or attached within their hosts; when attached, it is always by the tail-end.

The females are considerably larger than the males, from which they are easily distinguished by the tail, which in the male is coiled.

Historical.

Some confusion appears to exist as to the correct generic name of the Common Nematode of *Scyllium canicula*. The first generic name assigned was *Proleptus* by Dujardin (5) in 1845. He distinguished two species—*Proleptus acutus* and *Proleptus obtusus*, but as he gives neither description nor diagram of *Proleptus obtusus*, it may be considered invalid.

In 1860, Molin (11) described a nematode under the name of *Histiocephalus dachnodes*, which should apparently be referred to the genus *Proleptus*, as it differs considerably from the remaining species of *Histiocephalus* and appears to be wrongly placed. During the following year (1861) Van Beneden (2) described the worm under the generic name of *Spiropterina*.

Previous to Van Beneden placing it in a separate genus, it was provisionally assigned by Creplin (4) to the genus *Spiroptera*, chiefly because its head-end bore some slight resemblance to the *Spiropteras* of *Talpa*, *Erinaceus*, etc.

In 1870, Van Beneden (1) mentioned the worm under the generic name of *Coronilla*, and distinguished three new species:—*Coronilla scillicola*, *Coronilla robusta*, and *Coronilla minuta*. Neither the new genus nor the new species were described, but six drawings were given, which referred indiscriminately to two of the species—viz., *Coronilla robusta* and *Coronilla scillicola*.

Spiropterina appears to be the generic name by which the worm is most commonly known, but Linstow (7) has put forward a strong argument in favour of the name *Proleptus* on the ground of priority. For this reason I shall use the generic name *Proleptus*, but as Dujardin's species *acutus* evidently refers to a distinct species which occurs in *Scyllium catulus*, and his species *obtus* is difficult to determine, I propose to retain Van Beneden's specific name *scillicola*, and shall describe the worm under the name of *Proleptus scillicola*.

In addition to the foregoing, it has been briefly described by Linstow (9). My observations differ from those of Linstow in several respects, and his diagrams are inaccurate.

MORPHOLOGY.

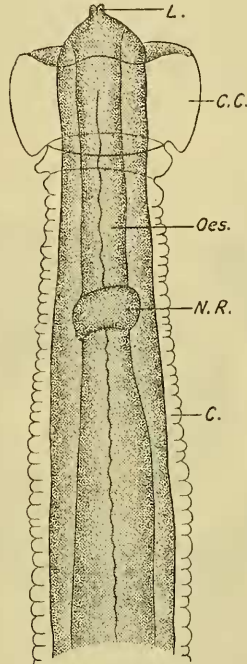
(a) *External Characters.*

The body is surrounded by a very thick, transparent cuticle, which is finely ringed transversely. *Proleptus scillicola* possesses extraordinary vitality. I have kept specimens alive in normal salt solution for over 17 weeks, whilst Linstow (9) records the fact that "specimens which had been in Müller's fluid for 48 hours arrived in a living condition."

The best results for whole mounts were obtained with Looss's fixative. Worms killed in this manner are straightened considerably and retain their transparency. Perenyi's fluid proved to be the best fixative for animals which were to be sectioned, whilst Para-carmin was the most effective stain.

The body is slightly attenuated towards the anterior end, and the head (text-fig. 1) is characterized by the presence of a peculiar cuticular collar. It was probably the presence of this collar which suggested to Van Beneden his generic name

Text-figure 1.

Head of *Proleptus scillicola*.

LETTERING OF FIGURES.

<i>A.</i>	Anus.	<i>Oes.</i>	Esophagus.
<i>Al.C.</i>	Alimentary canal.	<i>Ov.D.</i>	Oviduct.
<i>C.</i>	Cuticle.	<i>P.</i>	Papillae.
<i>C.C.</i>	Cuticular collar.	<i>R.</i>	Rectum.
<i>Cl.</i>	Cloaca.	<i>R.B.W.</i>	Right bursal wing.
<i>C.W.</i>	Cuticular wing.	<i>R.G.</i>	Rectal gland.
<i>I.</i>	Intestine.	<i>S.S.</i>	Small spicule.
<i>L.</i>	Lips.	<i>U.</i>	Uterus.
<i>L.B.W.</i>	Left bursal wing.	<i>Vu.</i>	Vulva.
<i>L.S.</i>	Large spicule.	<i>V.</i>	Vagina.
<i>N.R.</i>	Nerve-ring.		

Coronilla. There are two rounded, protruding, lateral lips, each of which bears a single conical tooth. Linstow (9) mentions in addition "interiorly a small pointed cone," but I have failed to find any evidence of this either in whole mounts or sections.

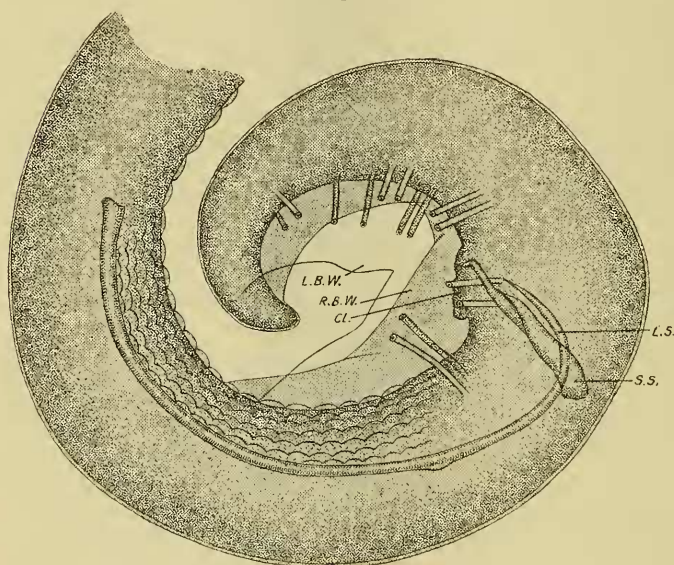
The excretory pore is exceedingly small, and is situated in the

mid-ventral line, almost as far distant posteriorly from the nerve-ring as the latter is from the anterior end.

The "tail" of the male (text-fig. 2) is coiled usually in a single ring, but occasionally into a spiral of two rings. There is an egg-shaped bursa, to right and left of which the cuticle is drawn out into wing-like expansions, supported by eight costal papillæ on each side. Van Beneden (2) states that there are six or seven papillæ on each side. These papillæ are pedunculate in form and are arranged symmetrically in two rows.

There is a single papilla at either end of each row; between the extreme papillæ are six others arranged in three pairs. One

Text-figure 2.



Lateral view of tail of male *Proleptus scillicola*, showing large and small spicules and costal papillæ.

pair is situated in the region of the cloaca, and the two remaining pairs are posterior to it. The pre-cloacal papillæ are somewhat longer than the remainder. Linstow (9) has figured three papillæ on each side of the cloaca, but after careful examination of many bursæ, I have failed to discover the third papilla.

Two copulatory spicules of unequal length are present, the left being approximately five times as long as the right. The average length of the longer spicule is 2.125 mm. and of the shorter .41 mm.

The longer spicule is curved towards the distal end, and at the beginning of the curvature there is a prominence on the convex

side. Linstow (9) has stated that the larger spicule is bent into a hook at its distal end, but I have not observed this arrangement in any of the worms I have examined. It is covered with numerous transverse markings, which give it a striated appearance under a fair magnification, and attenuates to a point at its distal end. Both spicules are ensheathed in cuticle.

The "tail" of the male ends bluntly, and in the neighbourhood of the spicules the cuticle is raised into rows of rounded elevations on the ventral surface.

The tail of the female (text-fig. 3) is bent at an angle to the body and is somewhat attenuated. In the region of the vulva the cuticle increases considerably in thickness on the ventral surface and forms a pad.

Measurements in the case of *Proleptus scillicola* are almost valueless, as there are wide variations not only in the sizes of individuals, but also in the proportions of different parts. The male varies considerably less than the female.

Mature females vary in length from 32.17 mm. to 59 mm., and the tail measures from .395 mm. to .583 mm. The proportion of tail: total length varies from 1:75.47 to 1:146.6. Linstow has given this proportion as 1:38.7.

The distance from the vulva to the tail-end varies from .887 mm. to 1.06 mm., and the proportion of "Vulva to tail end": total length varies from 1:39.7 to 1:53.07.

The males vary in length from 31.73 mm. to 36.2 mm. The tail measures from 1.03 mm. to 1.56 mm., and the proportion of tail: total length extends between 1:19.66 and 1:30.8. Linstow's proportion is given as 1:21.6. It would appear that Linstow has based his proportion on measurements of a single worm of each sex.

(b) Internal Anatomy.

The alimentary canal is normal, consisting of an œsophagus, intestine, and rectum.

The œsophagus is of unequal thickness, being approximately twice as broad behind the nerve-ring as it is in front of it. In the female it varies in length from 3.69 mm. to 5.86 mm., and the proportion of œsophagus: total length varies from 1:8.17 to 1:11.52. In the male the œsophageal length fluctuates between 3.6 mm. and 4.53 mm., and the proportion of œsophagus: total length from 1:7.32 to 1:8.81.

In transverse section the lumen of the alimentary canal is tri-radiate anteriorly, but towards the posterior portion of the intestine it becomes tetra-, penta-, or hexa-radiate.

Rectal glands occur around the anterior end of the rectum in both sexes. They are four in number and are symmetrically arranged.

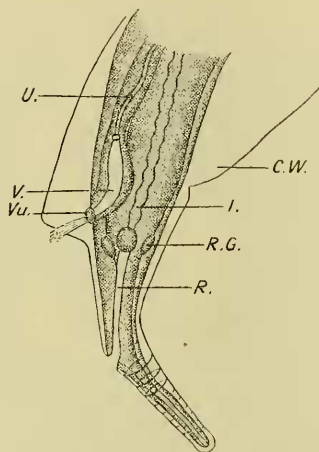
The female reproductive system is typical, and the vulva opens to the exterior, a short distance in front of the anus, on the ventral surface. The eggs are developed from a polynucleated

mass of protoplasm, and acquire distinctness as they approach the oviduct.

The ova vary in length from $47.5\ \mu$ to $52\ \mu$, and in breadth from $28.75\ \mu$ to $34.1\ \mu$. The thickness of the shell varies from $6.25\ \mu$ to $6.52\ \mu$. As a rule a coiled-up larva is formed within the shell before the "eggs" are extruded from the uterus.

It is possible to burst the "eggs" under a cover-glass and set free the contained larvæ, which average $201\ \mu$ in length. They are slightly attenuated towards the head-end, which is characterised by two protruding lips as in the adult, but there is no cuticular collar. The tail ends in a point, and is bent at an angle to the remainder of the body, but exhibits no sexual differentiation.

Text-figure 3.



Tail of mature female *Proleptus scillicola*.

The male reproductive system is of the usual type.

The excretory system consists of two canals, which pursue a sinuous course, one in each lateral line. From each canal a single branch descends to the ventral surface, where they unite just before reaching the excretory pore.

The nervous system consists of a well-defined circumoesophageal ring, which gives off numerous branches both anteriorly and posteriorly.

Life-History.

The literature dealing with the life-history of *Proleptus scillicola* is scanty. In 1865, McIntosh (10) described "The Trematode Larva and *Ascaris* of the *Carcinus maenas*." He discovered two specimens of his so-called *Ascaris*, one of which was lost, but his description of the other in some respects agrees with that of *Proleptus scillicola*.

In 1870, Van Beneden (1) stated that "Dr. McIntosh has found asexual nematodes in the 'liver' of *Carcinus maenas*, which appear to be the young of *Coronilla* (Van Beneden)."

Again, in 1875, Van Beneden (3a) stated that "The ordinary crab of our coasts, *Carcinus maenas*, is the vehicle of a nematode which becomes a *Coronilla robusta* in the stomach of a ray."

Vaullegeard (14) in 1896 reported the larva of *Coronilla robusta* (Van Beneden) from a number of crustaceans, but stated that it was rare. In addition to *Carcinus maenas*, he discovered it in *Portunus marmoratus* Leach, *Hyas araneus* Linnaeus, and *Pagurus bernhardus* Linnaeus, but found only one example in each of the last three hosts. Later he found a dozen nematode larvæ in *Portunus depurator* Pennant (= *P. marmoratus* Leach).

Linstow (9) mentions the discoveries of McIntosh and Vaullegeard, and states that the latter distributed the preparations of the larvæ, which indubitably belong to the genus *Spiropterina* (Van Beneden).

Experimental.

Following up the suggestion of Van Beneden, I have attempted to infect the Common Shore-Crab, *Carcinus maenas*, with the larvæ of *Proleptus scillicola*.

The results so far have been disappointing, as I have succeeded in obtaining only one larva, which I may reasonably assume to have developed from eggs, taken in with mature females of *Proleptus scillicola*, on which the crabs were fed.

During the course of these experiments I have dissected 100 crabs, of which 59 were utilised in the feeding experiments and the remainder in control experiments. Of the 59 crabs used in the feeding experiments, 8 were infected with *Proleptus larvæ*, 43 larvæ being found. Two of the 41 crabs used in control experiments were infected, six larvæ being found.

Owing to the fact that all the larvæ, except one, found in the crabs used in the feeding experiments were as old or older than those found in the controls, I am bound to conclude that they occurred as the result of natural infection.

The larva which I presume to be the result of my feeding experiments measured 1.85 mm. The length of the œsophagus was .35 mm., and the proportion œsophagus: total length was 1:5.28. There was no cuticular collar present, but the tail was bent at an angle to the remainder of the body.

The older larvæ examined varied in length from 10.16 mm. to 20 mm., and the length of the œsophagus from 1.79 mm. to 2.68 mm. The proportion œsophagus: total length fluctuated between 1:5.09 and 1:8.29.

In the majority of these older larvæ the head-end was surrounded by the cuticular collar which is so characteristic of the adult worm. Genital organs were absent, as was also differentiation at the tail-end.

I have dissected a number of specimens of *Pagurus bernhardus*, but have not found any larvæ of *Proleptus scillicola* in them.

Conclusions.

The above experiments show that the larvæ of *Proleptus scillicola* undoubtedly occur in *Carcinus menas*, but my failure to produce an artificial infection seems to point to the fact that *Carcinus* is not the true intermediate host.

It is possible, however, that *Carcinus menas* may play some part in the infection of the Dogfish. *Scyllium canicula* does not normally occur at a less depth than thirteen fathoms, whereas *Carcinus menas* rarely occurs below a depth of three to four fathoms. During the breeding-season, however, Dogfish come close inshore, and it is probable that some of its infection takes place at this season.

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